

**UNITED STATES PATENT APPLICATION****ASSIGNEE**

ANCHOR TOOL &amp; DIE COMPANY

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**TITLE OF THE INVENTION****AXIALLY ADJUSTABLE STEERING COLUMN ASSEMBLY WITH  
FLEXIBLE BEARING SLEEVE**

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**FIELD OF THE INVENTION**

The present invention pertains generally to steering column assemblies and, more particularly, to axially adjustable steering column assemblies for use in steering systems of vehicles.

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**BACKGROUND OF THE INVENTION**

- Axially adjustable steering column assemblies for vehicles are designed to extend and retract axially toward and away from the driver, and to be fixed in a desired axially extended or retracted position. A common arrangement uses an outer tube or jacket with one end oriented to the steering wheel and a distal end adapted to receive an inner tube or jacket, with appropriate clearance between the telescoping jackets. A desirable arrangement provides smooth, low effort telescoping extension and retraction, free of perceptible lash, or looseness, while providing high stiffness to resist deflection when a moment force is applied. A problem in practice pertains to the conflicting requirements of high vertical and lateral stiffness with low telescoping efforts.
- 20 The amount of lash and stiffness reduction can increase with extension of the column, or with decreased telescoping effort from too large a clearance between the jackets. Variances in telescoping tolerances which adversely affect smooth operation of column extension and retraction are caused by fluctuations in tube stock, warping from welding operations such as welded attachment of brackets to the tubes, and random moment forces as applied, for example,
- 25 through an attached steering wheel. These variances in telescoping forces also adversely affect the energy management function of steering columns designed to collapse in the event of a crash.
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A universal solution which reduces or eliminates lash and increases stiffness from all three of these sources while producing smooth, low effort telescoping operation would be desirable.

One approach involves the use of a sleeve between the opposing surfaces of the telescoped jackets. Such sleeves have been made of metal or plastic for interference fit between 5 the opposing surfaces of the jackets, with surface-to-surface contact with one or both of the jackets, and in some versions localized contact with the surface of the other jacket. This is accomplished by projections on one side of the sleeve which contact the opposing jacket surface. This localized contact, while effective in reducing telescoping effort, does not eliminate lash, and generally reduces vertical stiffness, particularly when a bending moment is placed on the column 10 assembly. Sleeves which fit directly over the inner jacket in surface-to-surface contact can transmit imperfections in the outer surface of the inner jacket, producing excess friction. A steering column assembly which provides both the correct amount of frictional resistance to axial movement of the telescoped members, with no lash, and which have high vertical stiffness is desired.

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#### SUMMARY OF THE INVENTION

The present invention is a telescoping column assembly for automotive or other vehicle applications. The invention provides controlled collapsing forces during vehicle crash impact in both telescoping and non-telescoping column assemblies. The telescoping column assembly includes an inner jacket telescopically received within an outer jacket, and a ribbed sleeve at the 20 telescoping interface of the inner and outer jackets. The ribbed sleeve has a plurality of protruding ribs on exterior and interior surfaces which interface respectively with the inner surface of the outer jacket and the outer surface of the inner jacket. In one embodiment, the ribs on the sleeve run parallel to the axial length of the sleeve. The ribs project from the interior surface of the sleeve and from the exterior surface of the sleeve, with a total cross-sectional 25 thickness through the inner and outer ribs being approximately equal to or greater than a clearance dimension between the inner and outer jackets, producing a frictional interference fit of the telescoping members. With the inner and outer ribs providing the contact surfaces between the jackets, the contact surface area and the resulting telescoping effort required is precisely controlled. The axial orientation of the ribs provides a relative radial displacement of select ribs 30 to remove lash in the column assembly. This anti-lash function of the ribbed sleeve can be

further enhanced by the introduction of a filler material in voids between the ribs and a jacket surface to provide high vertical and lateral stiffness, as further explained herein.

In accordance with one general aspect of the invention, there is provided a telescoping jacket assembly for use in combination with a telescoping steering column, the telescoping jacket assembly including an outer jacket, an inner jacket telescopically received within the outer jacket, a sleeve between the outer and inner jackets, the sleeve having a wall and at least two internal ribs which protrude from an interior of the wall and contact an outer surface of the inner jacket, and at least two external ribs which protrude from an exterior of the wall and contact an inner surface of the outer jacket to thereby space the wall of the sleeve from the outer jacket and the inner jacket.

In accordance with another aspect of the invention, there is invented a telescoping steering column assembly which includes an outer jacket with a first end and a second end; an inner jacket with a first end and a second end, the first end of the inner jacket dimensioned to be received telescopically within the second end of the outer jacket; a sleeve having a wall and positioned inside of the outer jacket at the second end of the outer jacket; the first end of the inner jacket positioned within the sleeve inside the outer jacket; the assembly configured for relative telescoping movement between the outer jacket and the inner jacket, with an outer surface of the inner jacket in contact with an inner surface of the sleeve, and an inner surface of the outer jacket in contact with an outer surface of the sleeve, the inner surface of the sleeve which contacts the outer surface of the inner jacket located on at least one internal rib which protrudes from the wall of the sleeve and is aligned with a longitudinal axis of the sleeve, and the outer surface of the sleeve which contacts the inner surface of the outer jacket located on at least one external rib which protrudes from the wall of the sleeve and is aligned with a longitudinal axis of the sleeve.

In one embodiment of the invention, an internal rib of the sleeve is radially offset from an external rib of the sleeve, thereby allowing flexure of the wall of the sleeve between the outer and inner jackets.

These and other features and advantages of the invention are further described in detail with reference to the accompanying drawing Figures.

## **DESCRIPTION OF THE DRAWINGS**

In the drawing Figures:

FIG. 1 is a cross-sectional view of a telescoping steering column assembly in accordance

5 with the present invention;

FIG. 2 is a axial cross-sectional view of the steering column assembly of FIG. 1, along the lines 2-2 in FIG. 1;

FIG. 3 is an enlarged cross-sectional view of the area of the steering column assembly indicated in FIG. 2, and

10 FIG. 4 is a perspective view of a ribbed tube component of the steering assembly of FIG. 1.

## **DETAILED DESCRIPTION OF PREFERRED AND ALTERNATE EMBODIMENTS**

As illustrated in the Figures, an axially adjustable column assembly with lash dampening  
15 is shown generally at 100, to include an outer jacket 110, an inner jacket 120 having an end 122 which is telescopically received within a distal end 112 of outer jacket 110, and a sleeve 130 positioned over end 122 of inner jacket 120 and within distal end 112 of outer jacket 110. In a particular installation in a vehicle, the inner jacket 120 may be fixed to surrounding structure, for example to the surrounding frame of an automobile, so that the outer jacket 110 telescopes  
20 relative to, in and out of, the inner jacket 120, along with a two-piece telescoping steering shaft 50 attached to steering wheel 51. Alternatively, the outer jacket 110 may be fixed, with the inner jacket 120 able to telescope relative to the outer jacket 110, and with the steering wheel oppositely configured.

As shown in FIGS. 2A, 2B, 3 and 4, sleeve 130 is provided with internal ribs 132 dimensioned for contact with the outer surface of inner jacket 120, and external ribs 134 dimensioned for contact with the inner surface of outer jacket 110. The internal ribs 132 are preferably radially offset from the external ribs 134 as shown in FIG. 2, although other positions and configurations of ribs are within the scope of the invention, as further described herein, such as the internal and external ribs being radially aligned, or partially radially offset with some overlap of the respective contact surfaces, or radially offset completely with no overlap of the

respective contact surfaces. The sleeve 130 preferably remains fixed inside of the outer jacket 110, and in sliding or slidable contact with an inner surface of the outer jacket 110.

Alternatively, the sleeve 130 may be fixed relative to the inner jacket 120 and in sliding or slidable contact with outer jacket 110.

5       The amount of contact area of the external and internal ribs 132, 134 of the sleeve 130 with the opposing jacket surfaces is determined by the width of the ribs, which can be selectively designed according to the amount of static and kinetic friction desired in the column assembly. In this embodiment, the total sliding contact surface area of the sleeve 130 is the combined surface area of the internal ribs 132 relative to the inner jacket 120, with the sleeve remaining 10 fixed relative to the distal end 112 of outer jacket 110. The areas 133 between the internal ribs 132 and the outer surface of inner jacket 120 are left open. One or more of the areas 135 between the external ribs 134 and the inner surface of outer jacket 110 can be filled or partially filled with a material 136, such as a filler or bonding material, such as an adhesive, or elastomer or polymer which may have adhesive and elastic properties, or any other material or materials of 15 comparable performance. The filling of area or areas 135 with material 136 compensates for small variations in the wall of outer jacket 110 and also stiffens the sleeve 130 which provides the telescoping bearing surface for the inner jacket 120 as further described. The sleeve 130 does not simply conform to the internal surface of outer jacket 110 as a liner, but rather the presence of external ribs 134 defines the contact surface area between the jackets and enables the sleeve to 20 accommodate both to the interior surface of outer jacket 110 along with any imperfections therein, and to accommodate to the exterior surface of inner jacket 120 as further described. The performance of sleeve 130 as a type of flexible linear bearing can be further tuned by selective placement of material 136 within only certain of areas 135, such as for example those areas 135 located at the radial top and/or bottom of the column (i.e., 0° and 180°) to stiffen the assembly in 25 this dimension most likely to receive an externally applied moment force. Although the sleeve 130 is described in this embodiment as fixedly secured or bonded to the outer jacket 110, other relative arrangements of the components are contemplated as within the scope of the invention. For example, in telescoping column systems in which the inner jacket moves relative to the outer jacket, the sleeve 130 may be fixedly secured to the outer surface of the inner jacket, with the 30 external ribs 134 sliding against the inner surface of the outer jacket.

As further shown in FIGS. 2-4, internal ribs 132 define the sliding contact surface areas with the outer surface of inner jacket 120. Placement of the internal ribs 132 in a radially offset arrangement relative to external ribs 134, as shown in FIGS. 2A and 4, enables the wall 131 of sleeve 133 to flex, to thereby accommodate any undulations or variations in the outer surface of inner jacket 120 as it slides along the length thereof in the telescoping operation. Similarly, if the sleeve 130 is fixed relative to the inner jacket 120, the radially offset internal and external ribs 132, 134 allow the wall 131 of the sleeve to flex in order to accommodate variations in the internal surface or internal diameter dimension of the outer jacket 110.

Alternatively, as shown in FIG. 2B, sleeve 130 may be friction fit within outer jacket 110 by contact of biasing ribs 137, which are located radially opposite selected internal ribs 132, or radially opposite each of the internal ribs 132, with external ribs 134 positioned radially between as shown in FIG. 2B. Biasing ribs 137 eliminate the need for a bonding material 136 in areas 135, by compressing the external ribs 134 against the interior of outer jacket 110 to securely position the sleeve 130 between the jackets. With areas 135 left open, the wall 131 of the sleeve 15 130 is free to flex in a radial directions as described. The friction fit of the enlarged biasing ribs 137 within outer jacket 110 causes some radial distortion of the sleeve and the contact surfaces of internal ribs 132. This can be corrected by machining the inner diameter of the sleeve 130 or of the contact surfaces of internal ribs 132 after the sleeve is installed in outer jacket 110 to the correct tolerance to receive inner jacket 120. Any variations in the outer surface of inner jacket 20 120 are then accommodated for by the flexure of the wall 131 of sleeve 133. Alternatively, the internal and external ribs 132, 134 of the sleeve 130 may be partially radially offset so that the contact surface areas of the ribs partially radially overlap, as shown for example at the bottom of FIG. 2B.